

## Load Carriage and what it means for Search & Rescue

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UNIVERSITY**

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*Load Carriage  
and what it means for  
Search & Rescue*



## CONTENT:

- Load carriage context
- Risks associated with load carriage
- Risk enhancers
- Load carriage conditioning



# MILITARY CONTEXT



[http://img266.imageshack.us/img266/9808/digger\\_ssmg28.jpg](http://img266.imageshack.us/img266/9808/digger_ssmg28.jpg)



[http://4.bp.blogspot.com/\\_BZQXUhgZR3A/S9Tzq\\_w6uOI/AAAAAAAAABE/HGGoRbjaoU/s1600/vietnam-peter-b.jpg](http://4.bp.blogspot.com/_BZQXUhgZR3A/S9Tzq_w6uOI/AAAAAAAAABE/HGGoRbjaoU/s1600/vietnam-peter-b.jpg)



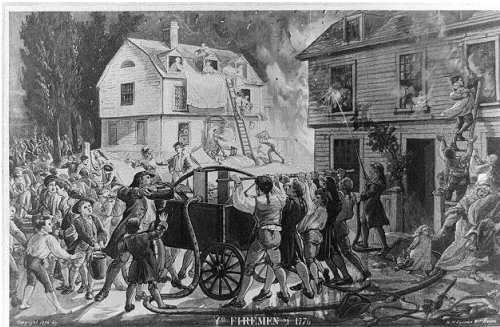
[http://upload.wikimedia.org/wikipedia/commons/5/5a/Australian\\_soldier\\_Afghanistan\\_Aug\\_2008.jpg](http://upload.wikimedia.org/wikipedia/commons/5/5a/Australian_soldier_Afghanistan_Aug_2008.jpg)



# FIREFIGHTER CONTEXT

- Context and scope of practice has changed

1770



[http://upload.wikimedia.org/wikipedia/commons/thumb/6/66/Old\\_firefighters.jpg/220px-Old\\_firefighters.jpg](http://upload.wikimedia.org/wikipedia/commons/thumb/6/66/Old_firefighters.jpg/220px-Old_firefighters.jpg)

1879



[http://upload.wikimedia.org/wikipedia/commons/4/43/Vintage\\_firefighters.jpg](http://upload.wikimedia.org/wikipedia/commons/4/43/Vintage_firefighters.jpg)

2012



<http://www.stacksplace.com/EMS/ftadd1.jpg>





# LAW ENFORCEMENT CONTEXT

1890s



[http://2.bp.blogspot.com/-xHtSiLRFIMQ/UfewLRnEgAI/AAAAAAAIpc/54yapn\\_iBtE/s1600/Curious+Black+&+White+Photographs+of+The+Police+Officers+from+1890-1930+\(28\).jpg](http://2.bp.blogspot.com/-xHtSiLRFIMQ/UfewLRnEgAI/AAAAAAAIpc/54yapn_iBtE/s1600/Curious+Black+&+White+Photographs+of+The+Police+Officers+from+1890-1930+(28).jpg)

1970s



[http://3.bp.blogspot.com/-HO26ffMhqS4/UihkEhycrol/AAAAAAAMR4/qGsg2ryfWKA/s640/Pictures+of+Life+of+the+New+York+Police+Department+in+the+1970's+\(7\).jpg](http://3.bp.blogspot.com/-HO26ffMhqS4/UihkEhycrol/AAAAAAAMR4/qGsg2ryfWKA/s640/Pictures+of+Life+of+the+New+York+Police+Department+in+the+1970's+(7).jpg)

2010



<http://images.smh.com.au/2012/12/04/3861588/artist-police-uniforms-620x349.jpg>

<http://images.smh.com.au/2009/03/09/410908/policebelt.jpg>



[http://www.gunblast.com/images/WBell\\_PoliceHolsterHistory/Police-Holster-History-012.jpg](http://www.gunblast.com/images/WBell_PoliceHolsterHistory/Police-Holster-History-012.jpg)





# SAR CONTEXT



<http://bloximages.newyork1.vip.townnews.com/estesparknews.com/content/tncms/assets/v3/editorial/d/c7/dc7f6316-1ea7-11e5-a8eb-bb1f7936f02c/5591bc1ee90b6.image.jpg>



<http://www.medicinac.si/wp-content/uploads/2013/10/img51351803309img5092e1ada9b3c.jpg>



<http://www.sandia.gov/news-center/news-releases/2004/images/SAR-map.gif>





# SAR CONTEXT

Conolly et al., 2015

- Prolonged hiking with loaded backpack (30–50 lbs), helmet, and harness in mountainous terrain
- Litter loads can be in excess of 100 lbs
- Maintain squat or semi-squat position with around 17% BW load.







# RISKS ASSOCIATED WITH LOAD CARRIAGE

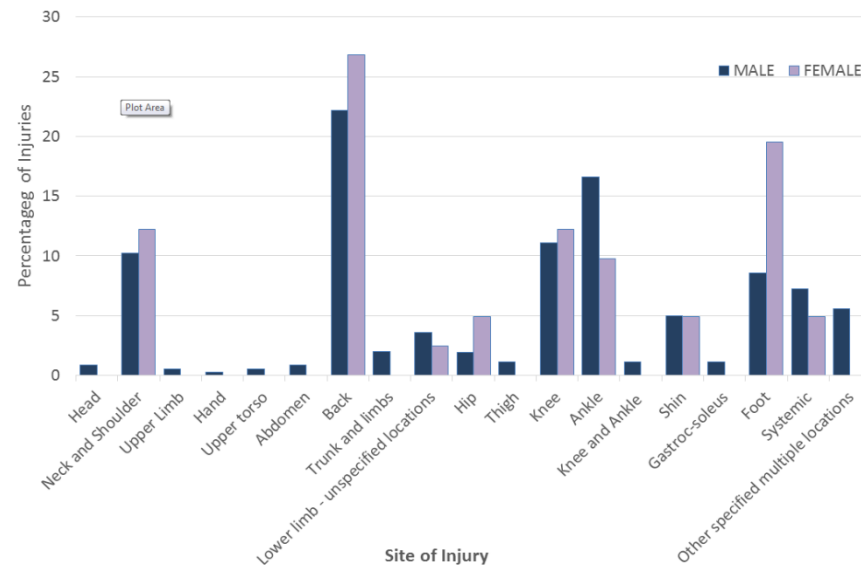
- Injuries: Associated with a variety of injuries (from skin blistering to muscle, ligament, tendon, bone and nervous system injuries)





# RISKS ASSOCIATED WITH LOAD CARRIAGE

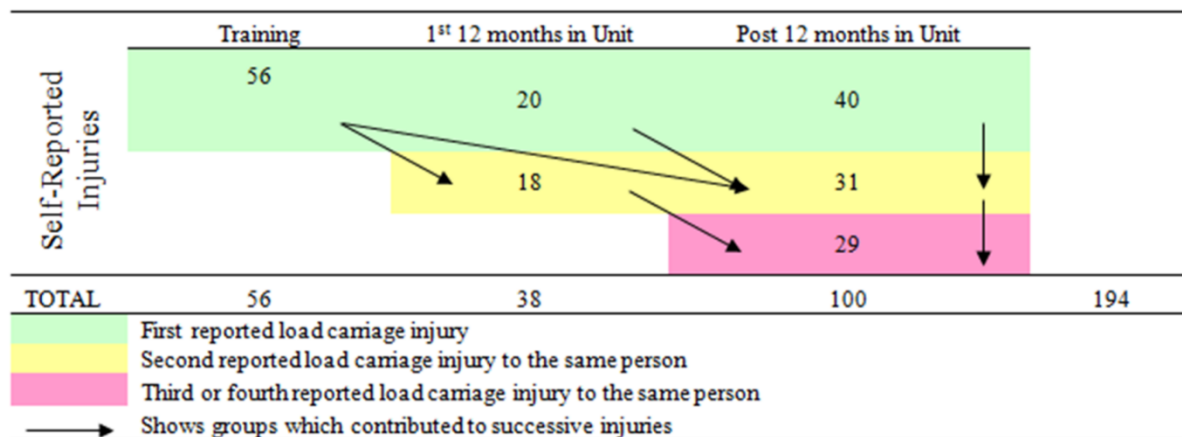
- Some differences may exist between genders





# RISKS ASSOCIATED WITH LOAD CARRIAGE

- Once injured – more likely to be reinjured



Orr, R., Pope, R., Coyle, J. & Johnston, V. (2016). Self-reported load carriage injuries in Australian Regular Army soldiers, *International Journal of Injury Control and Safety Promotion*, pp. 1-9 <http://dx.doi.org/10.1080/17457300.2015.1132731>



# RISKS ASSOCIATED WITH LOAD CARRIAGE

- Decrements in performance:
  - ↓ Mobility
    - Increased risk of trip and fall
    - Decreased ability to negotiate escape routes



[http://mountainenterprise.com/fds/images/story/fs\\_4764.jpg](http://mountainenterprise.com/fds/images/story/fs_4764.jpg)



<http://us-news.us/wp-content/uploads/2015/09/wp-id-635780139405791932-Flash-Flood-114.jpg>







# RISK ENHANCING FACTORS

- $\uparrow$  in load weight =  $\uparrow$  in the energy cost of standing, walking (forwards and backwards, up and down stairs) and running
- $\uparrow$  in speed of load carriage =  $\uparrow$  in the energy cost of carrying given load (more than weight)?  
 $\uparrow 0.5\text{km/h} = \uparrow 10\text{kg}$



# RISK ENHANCING FACTORS

- $\uparrow$  in gradient of load carriage =  $\uparrow$  in the energy cost of carrying given load (more than weight)?  
 $\uparrow 1\% = \uparrow 10\text{kg}$



<https://www.stgeorgeutah.com/wp-content/uploads/2012/03/wsr-1a.jpg>



[http://mountainenterprise.com/fds/images/story/fs\\_4764.jpg](http://mountainenterprise.com/fds/images/story/fs_4764.jpg)



# RISK ENHANCING FACTORS

- Different terrain types will elicit different energy cost requirements  
(*road-light brush-heavy brush-sand*)



<http://nebula.wsimg.com/cbb11ca9cde7d368b56c5b7339d688c?AccessKeyId=FE8612ED32EE26907E09&disposition=0&alloworigin=1>



<http://crowboroughlife.com/wp-content/uploads/2015/02/Search-and-Rescue.jpg>



<http://d1udmfvw0p7cd2.cloudfront.net/wp-content/uploads/2014/10/n-searchresume-b-20141002-870x575.jpg>





# RISK ENHANCING FACTORS

- Differences in load placement will elicit differences in energy cost.
  - Weight on the feet more costly than the back
  - Thigh more costly than back (0.5kg ↑ cost by 3.5%)
  - Shoulder more costly than back
  - Hands around 2 x more costly than back\*



<https://waynemerry.files.wordpress.com/2014/06/p5030797.jpg>





# RISK ENHANCING FACTORS

- Soule and Goldman (1969) found the cost of carrying a 7 kg load in the hands to be nearly twice that of carrying the load on the torso.
- Datta and Ramanathan (1971) observed a significantly higher ( $p < .05$ ) cost of load carriage in the hands (mean of 6.96 KCAL/min) than on the back (mean of 5.27 KCAL/min).

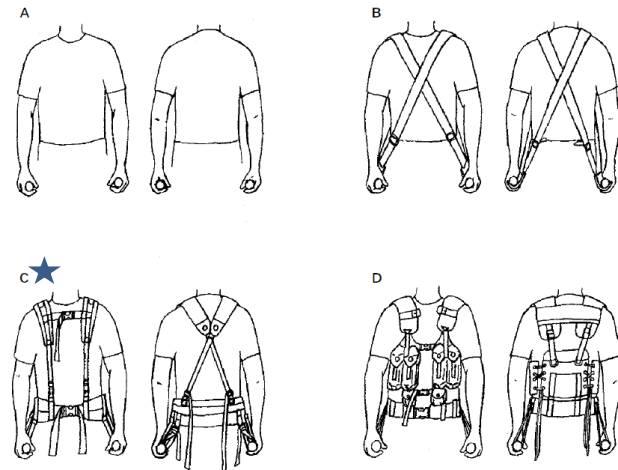


# RISK ENHANCING FACTORS

- Knapik et al., 2000
  - Load carriage times were significantly shorter when loads were carried in the hands (81 – 88%;  $p < .01$ ) when compared to the innovative methods.



<http://woodheadmrt.org/wp-content/uploads/2015/09/woodheadmrt1200.jpg>





# RISK ENHANCING FACTORS

- Unilateral v Bilateral Loads in the hand
  - Unilateral hand loading can:
    - increase hip muscle activity to twice that for the same load carried bilaterally (Neumann, Cook, Sholty, & Sobush, 1992),
    - cause gait asymmetry (Zhang, Ye, & Wang, 2010) and
    - potentially increase further energy expenditure (Datta & Ramanathan, 1971).



<http://www.grough.co.uk/lib/img/editorial/caldervalleyhardcastlerescue.jpg>





# LOAD CARRIAGE CONDITIONING

- Concept is not new (*Flavius Vegetius Renatus - Epitoma rei militaris*)
- Common in military training but in SAR?







# LOAD CARRIAGE CONDITIONING

Research by Orr et al. (2010) and Knapik et al., (2012) recommend:

- F.I.T.T Formula (Frequency, Intensity, Time & Type)
  - F. 7-10 days per load carriage session
  - I. To loads required at the speeds and over the terrains required
  - T. Duration of load carriage operations
  - T. Load carriage preferable, but combined resistance and cardio may be of some benefit



# LOAD CARRIAGE CONDITIONING

- Specificity



<http://www.grough.co.uk/lib/img/editorial/KirkbystephenCautley-Spout-2.jpg>



<http://blog.nhstateparks.org/wp-content/uploads/2012/04/Search-Rescue-litter-passing-over-rough-terrain.jpg>



## Take Home Messages

- Load carriage reduces performance and can cause injuries = decreased operational success
- Load carriage is about more than the load weight, terrain type and grade, speed of movement and load position must be taken into account
- To minimise the risk of injury and increase the potential for operational success SAR personnel need to be conditioning to carry load





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<https://bond.edu.au/tru>